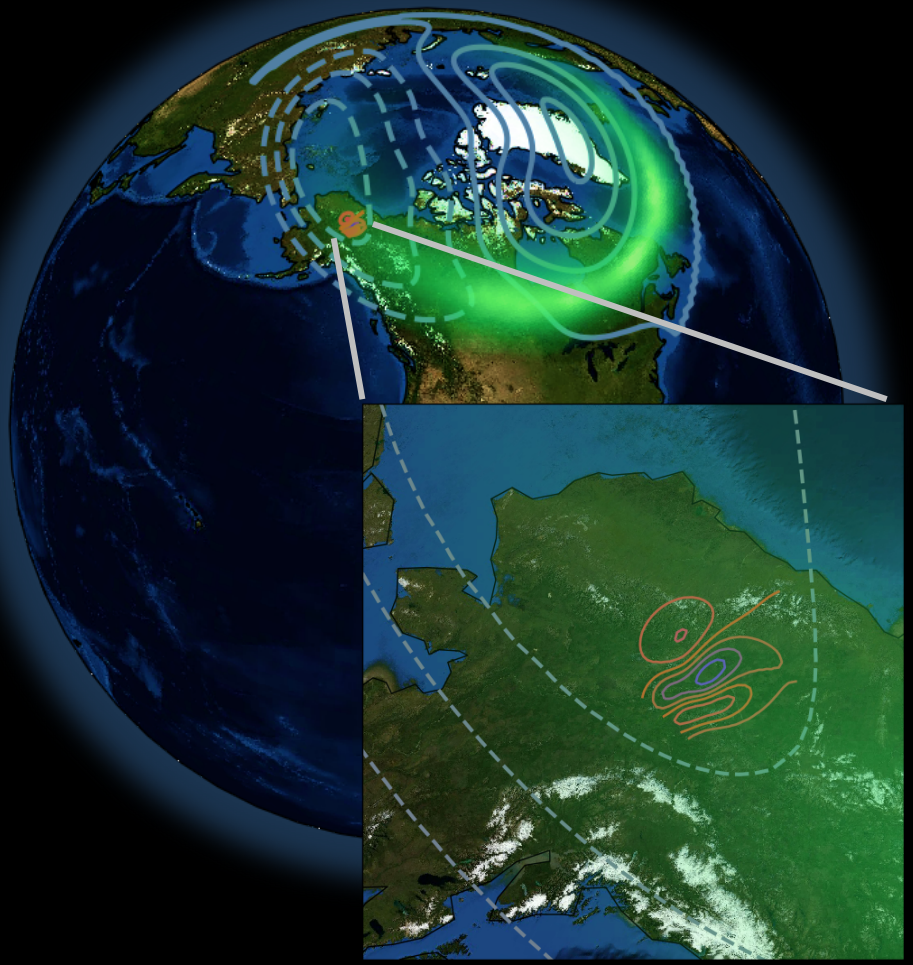

High-latitude Input for Meso-scale Electrodynamics: HIME

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Xing Meng[1], Olga Verkhoglyadova[1],

Roger Varney[2], Ashton Reimer[2], Josh Semeter[3]

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Ionospheric Structuring: In Situ and Groundbased Low Altitude Studies (ISINGLASS) Experiment

PI: Kristina Lynch – Dartmouth College

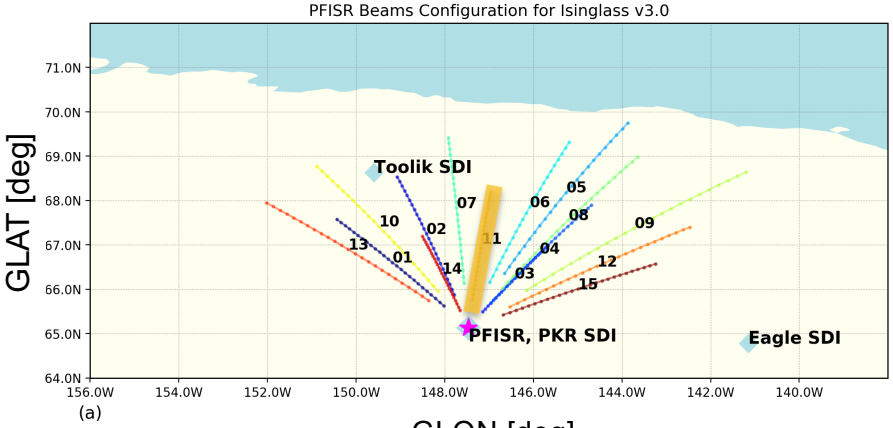
Robert Clayton (Dartmouth), Matt Zettergren (ERAU), Meghan Burleigh (ERAU-UMich), Mark Conde (UAF), Guy Grubbs (GSFC), Don Hampton (UAF), David Hysell (Cornell), Marc Lessard (UNH), Robert Michell (UMD), Ashton Reimer (SRI), T. Maximillian Roberts (Dartmouth-JPL), Marilia Samara (GSFC), Roger Varney (SRI)

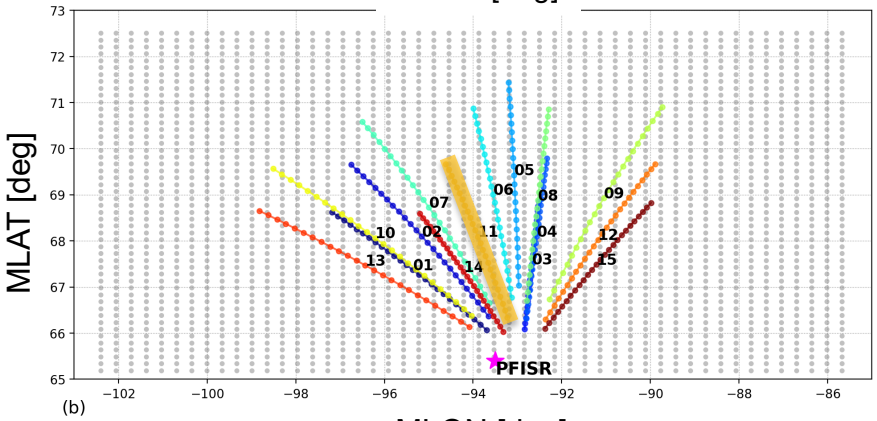
Aim: Sampling multiple locations simultaneously in the auroral ionosphere to take gradient measurements of plasma parameters.

[Clayton et al., 2019a, b]

Credits: NASA/Terry Zaperach

Running a global I-T model with ISR estimates of electric field





Ozturk et al., in review, JGR

Modelling:

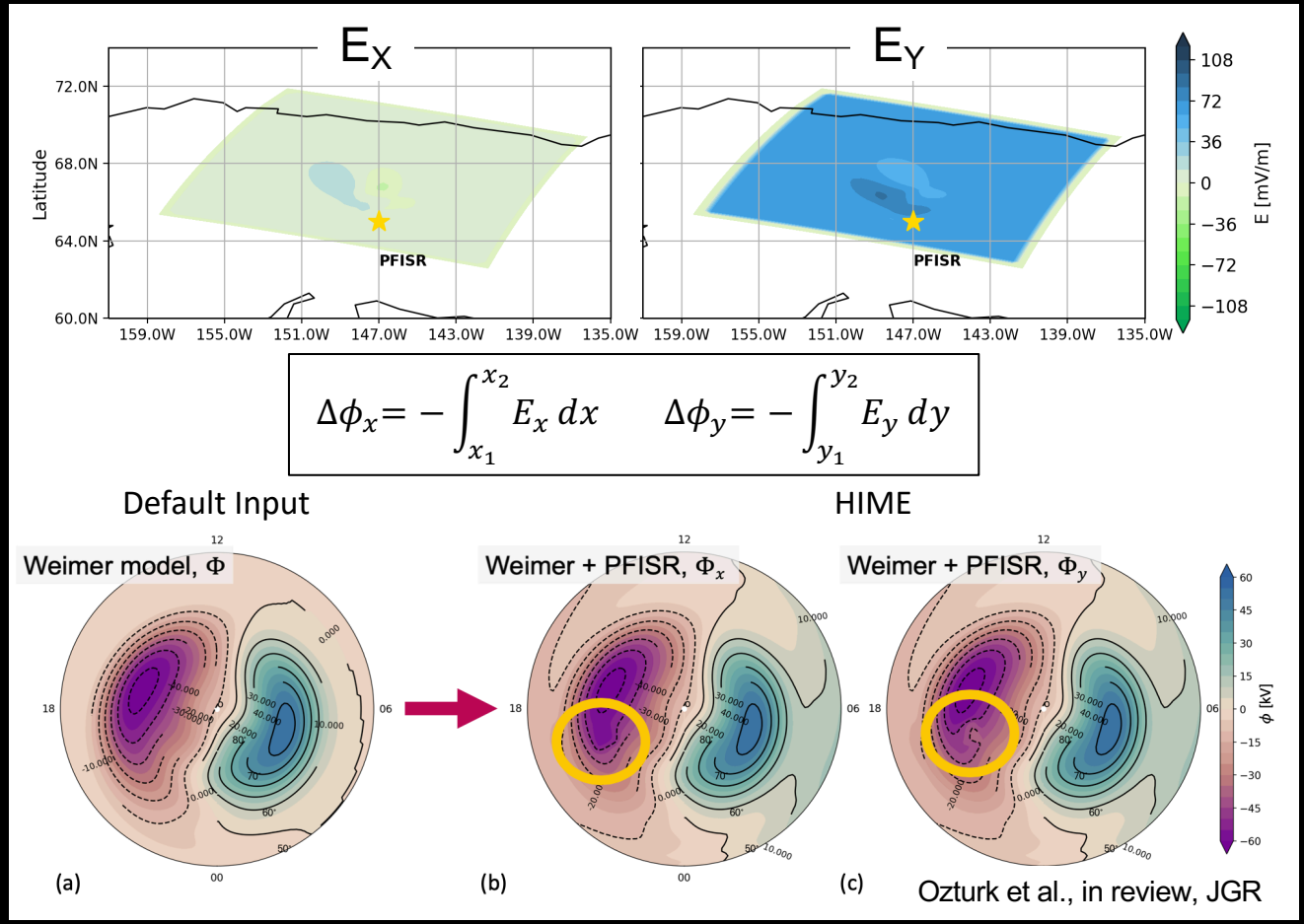
- PFISR aiding the ISINGLASS experiment
- The electric field estimates from 15 beams:
  - Temporal resolution [66 seconds]
  - Spatial resolution [0.05° in lat and 0.3° in lon, ~10 km]
  - Down-sampled to 0.75°x0.75°: 35x80 km

Validation:

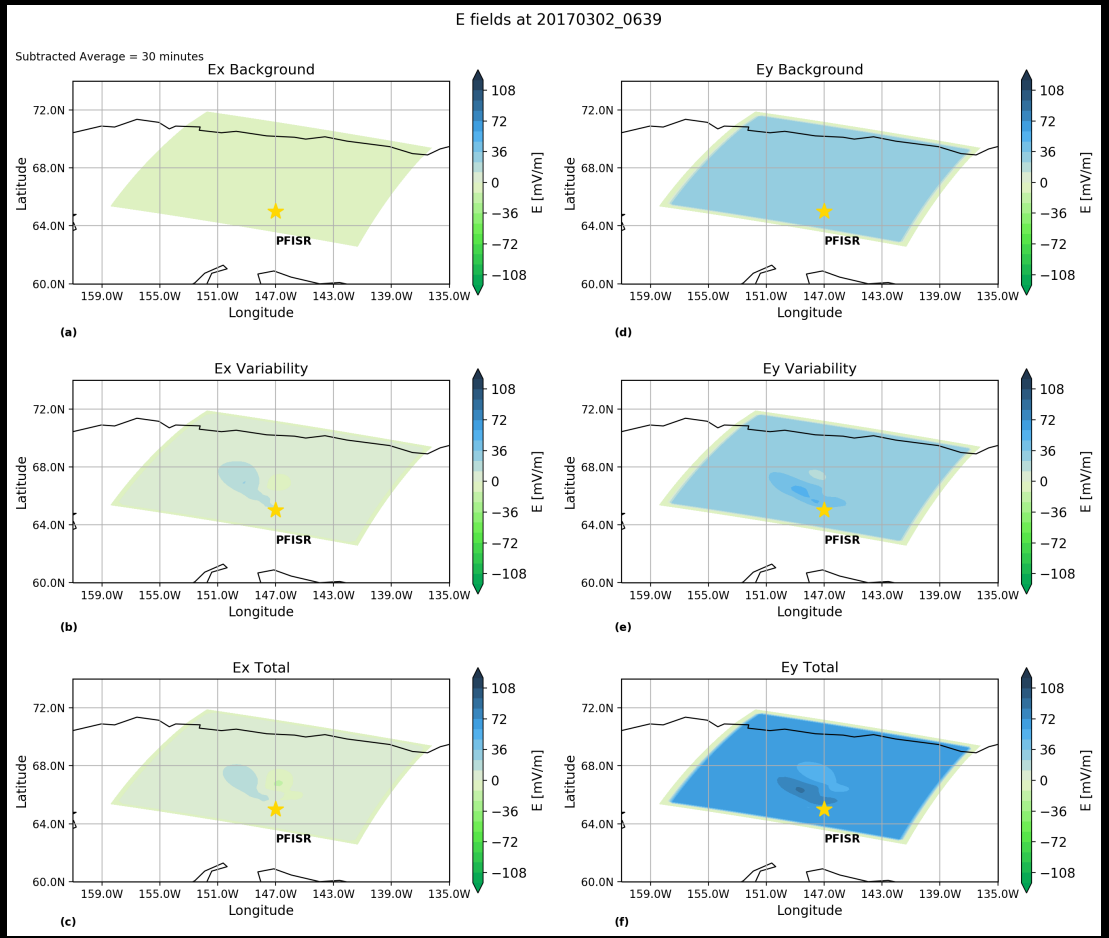
- Plasma measurements along Beams

High-latitude Input for Meso-scale Electrodynamics: HIME

- Nicolls et al. (2014) technique estimates F-region electric fields on a 2-D grid from the PFISR V_{LOS} measurements.
- These estimates can be merged with a <u>global empirical potential model</u> to drive global I-T models and investigate the role of meso-scale electric fields.



Methodology IV: Simulation setup



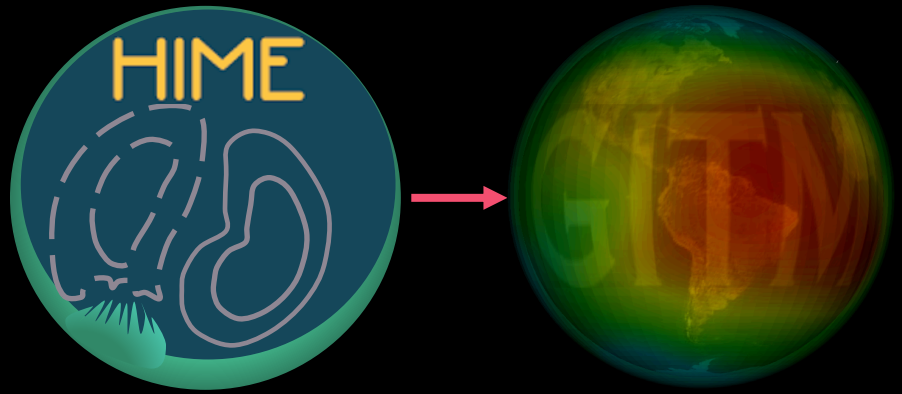
- Weimer model results are weaker (~0-10 mV/m) than the PFISR electric field values.
- To asses the performance of the new model vs understanding the effects of variability:

$$E_{total} = E_{background} + E_{variability}$$

where $E_{background}$ 30 min. boxcar average.

Simulations	Potentials
1	Weimer Electric Field Potentials
2	Measured Electric Field Potentials
3	Background Electric Field Potentials
4	Variable Electric Field Potentials

Running a global I-T model with HIME



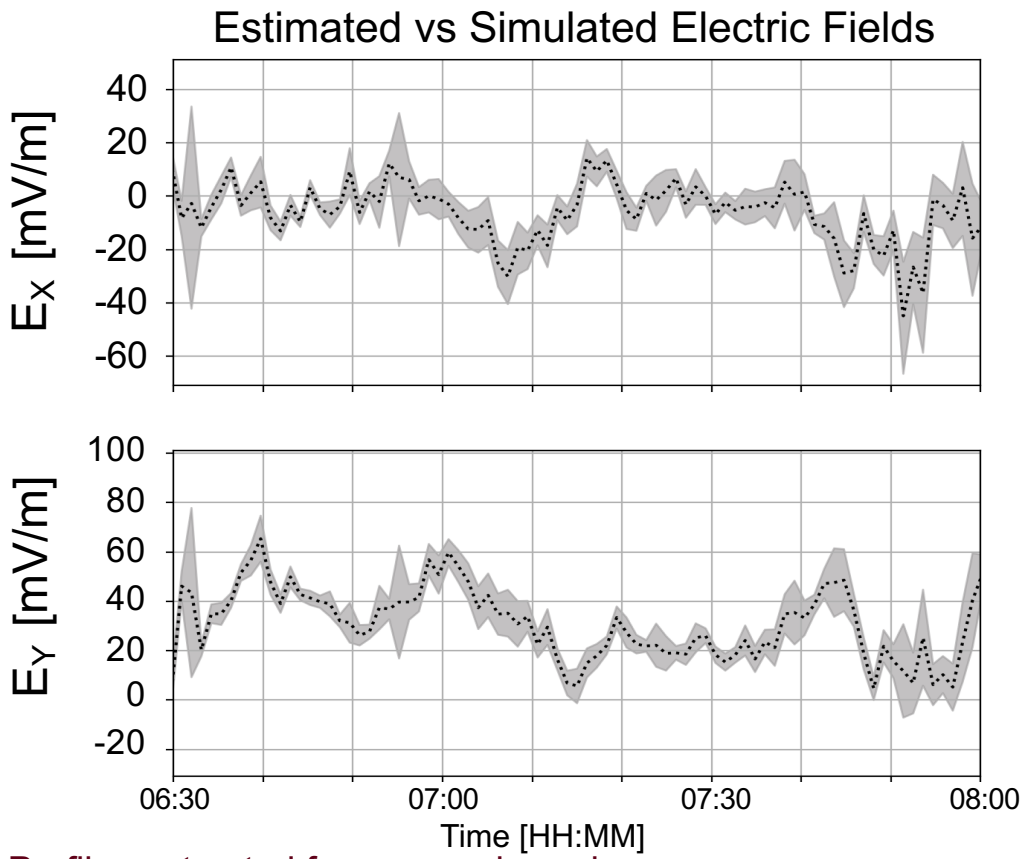
HIME is an add-on framework and does not require major source code modification.

Global Ionosphere -Thermosphere Model (GITM)

- 3D, altitude based non-uniform grid, assumes non-hydrostatic solution
- High-latitude input: Electric potential and particle precipitation
- Output: Plasma and neutral density, temperature, ion and electron velocity, neutral winds

Ridley, Deng and Toth, JASTP, 2006

Meso-scale electric fields in GITM

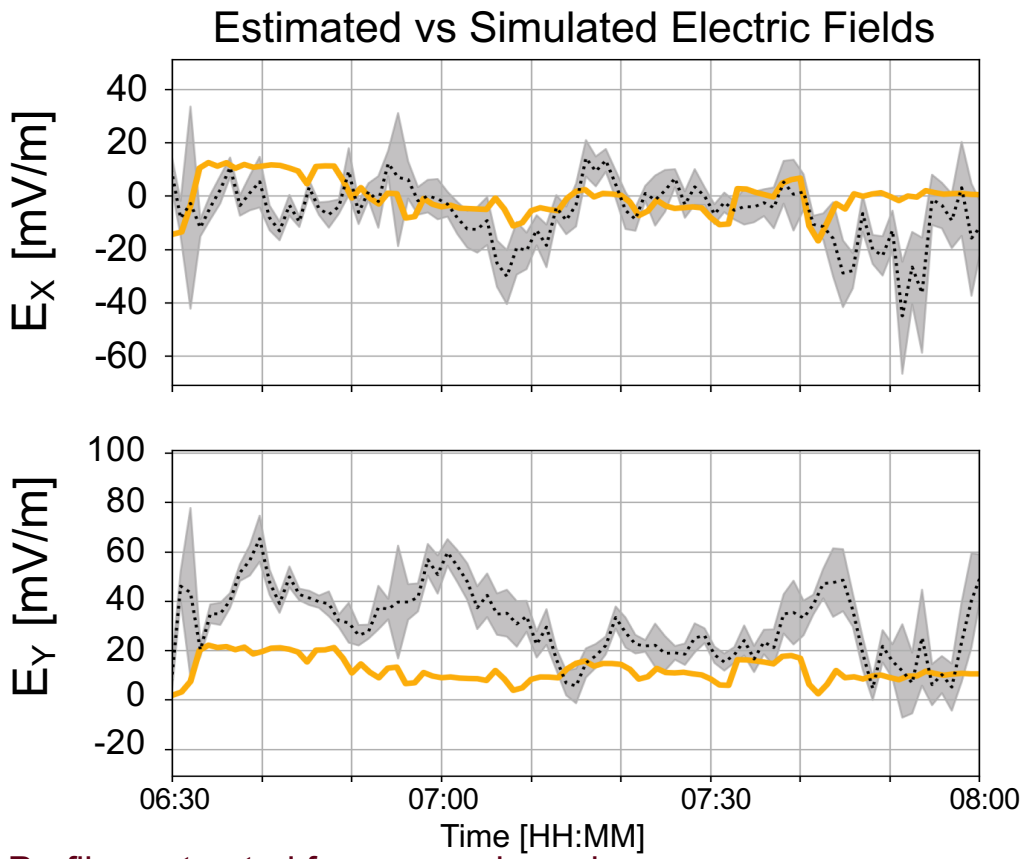


PFISR Estimates

Errors

* Profiles extracted from upper boundary.

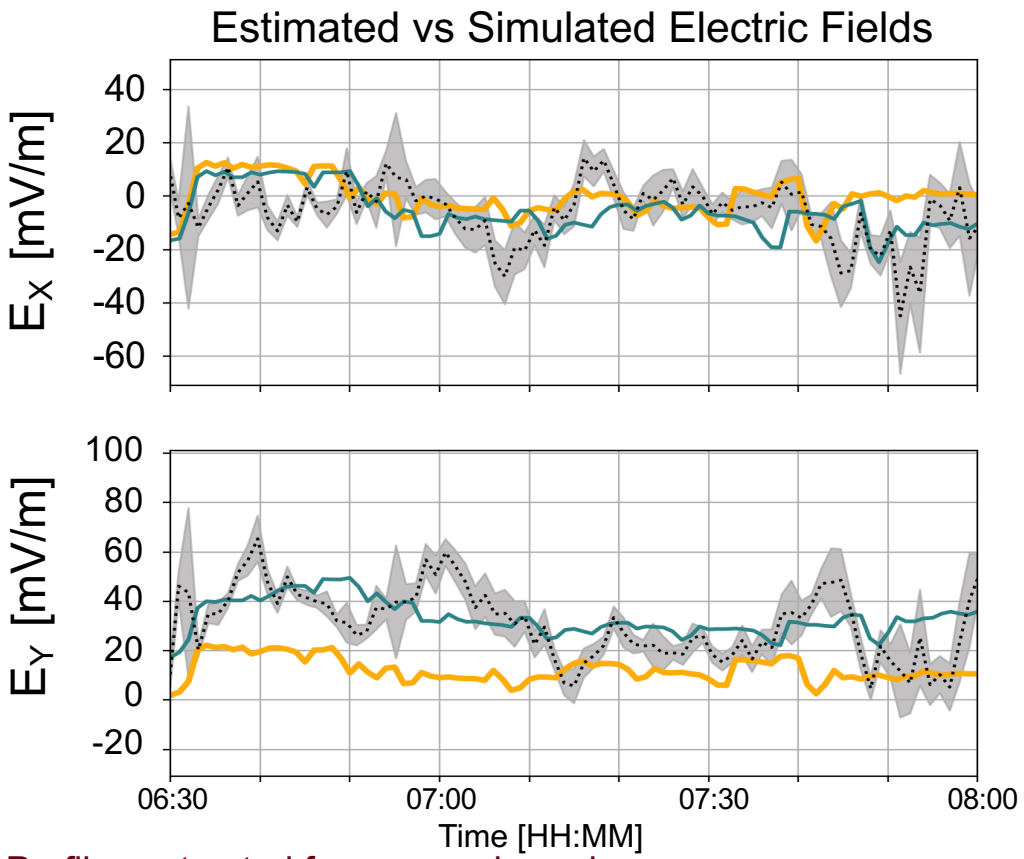
Meso-scale electric fields in GITM



PFISR Estimates
Errors
Weimer-driven GITM Runs

* Profiles extracted from upper boundary.

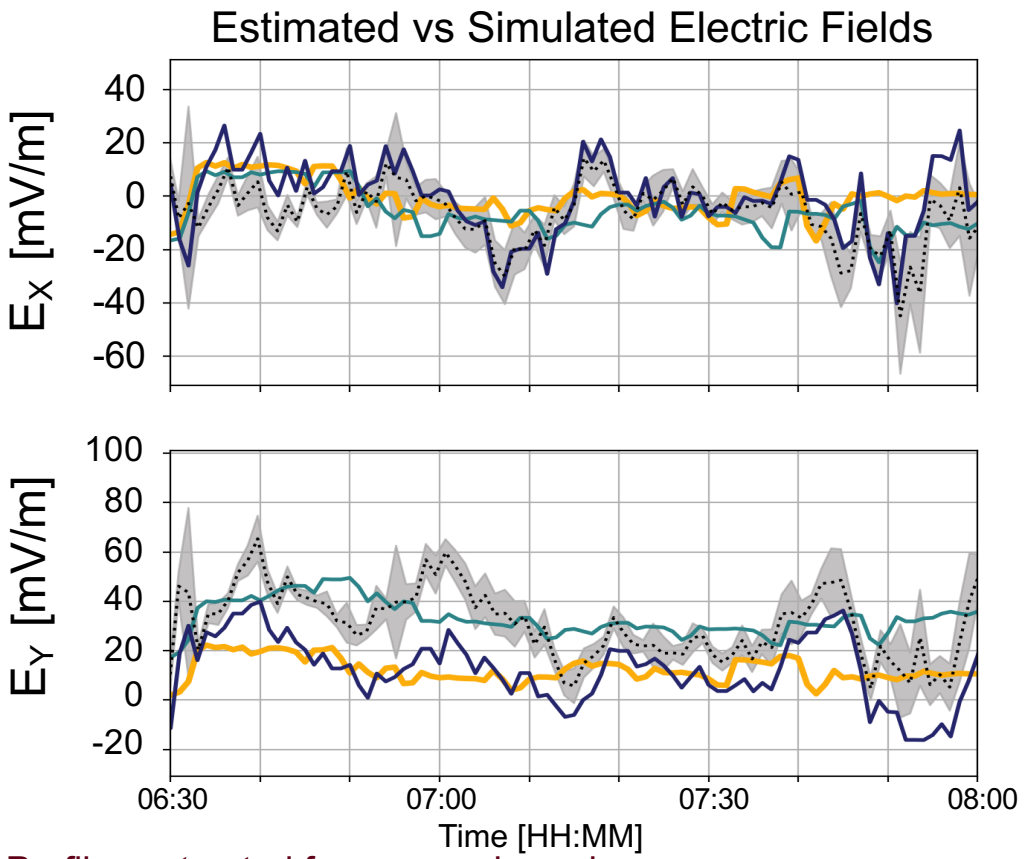
Meso-scale electric fields in GITM



PFISR Estimates
Errors
Weimer-driven GITM Runs
HIME[B]-driven GITM Runs

* Profiles extracted from upper boundary.

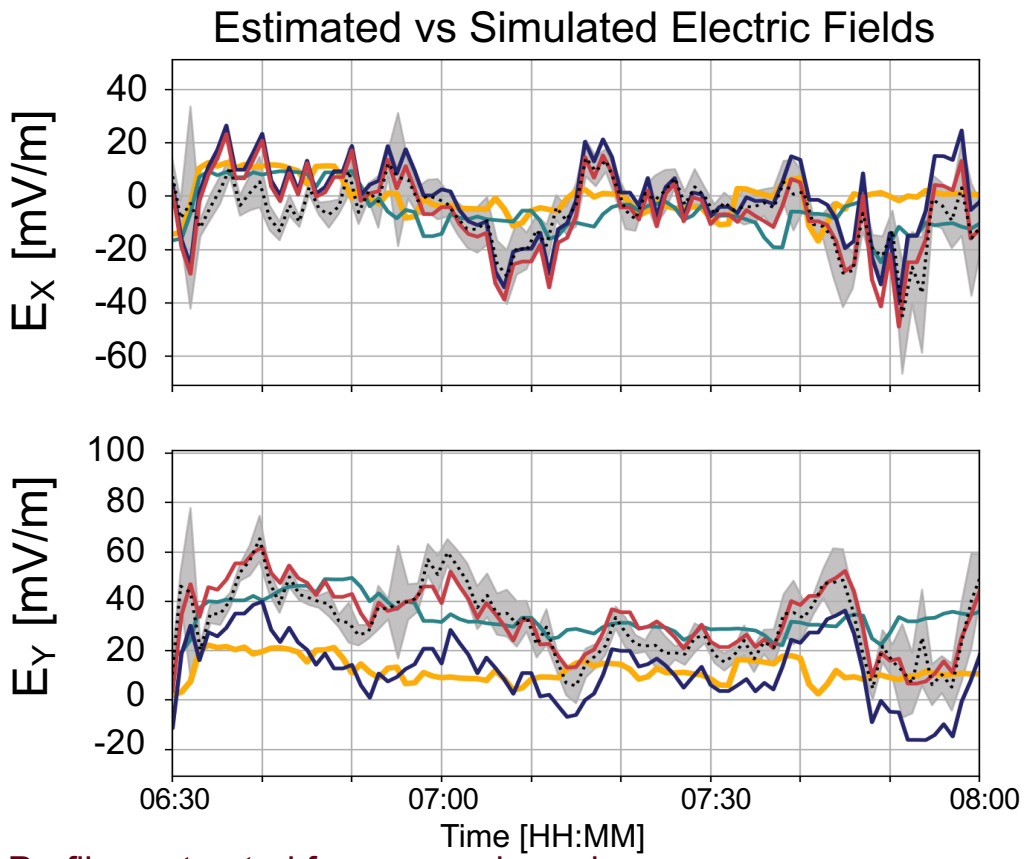
Meso-scale electric fields in GITM



PFISR Estimates
Errors
Weimer-driven GITM Runs
HIME[B]-driven GITM Runs
HIME[V]-driven GITM Runs

* Profiles extracted from upper boundary.

Meso-scale electric fields in GITM

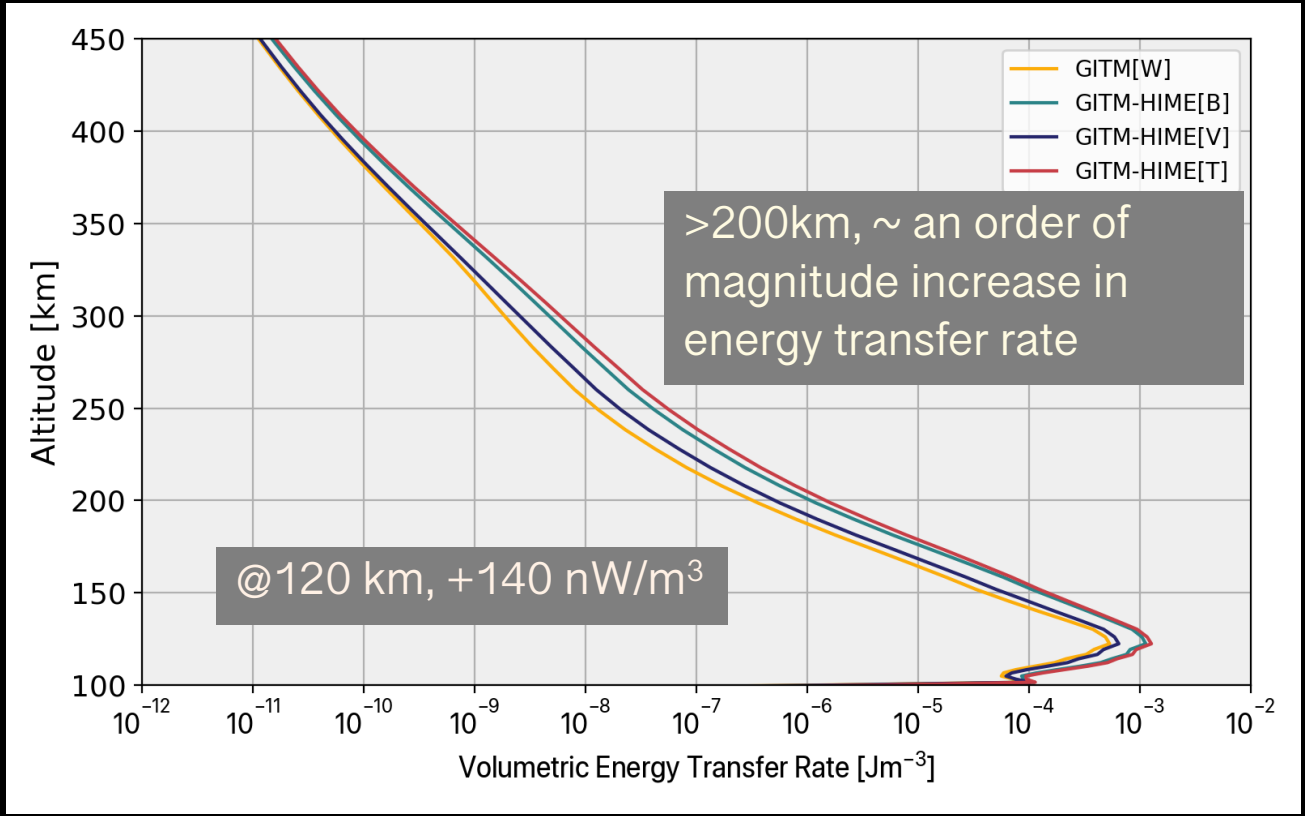


* Profiles extracted from upper boundary.

- PFISR Estimates
- Errors
- Weimer-driven GITM Runs
- HIME[B]-driven GITM Runs
- HIME[V]-driven GITM Runs
- HIME[T]-driven GITM Runs

- Both variability and amplitude are better captured with HIME.
- Electric field estimates from PFISR successfully incorporated.

Energy transfer rate with meso-scale electric fields



- Meso- and small- scale structures have been shown to have a profound effect on local heating*.
- The locally deposited energy increases in HIME-driven simulation compared to Weimer-driven simulation.

* Verkhoglyadova et al., 2018; Lotko and Zhang, 2019

Effects of Meso-scale electric fields in the I-T system

For the first time a framework has been developed to incorporate ISR estimates of 2D electric fields to global I-T models.

The HIME driven simulations showed that meso-scale electric fields can lead to:

- Various changes in plasma parameters.
- Up to an order of magnitude increase in volumetric heating along the altitudinal profiles.

Ongoing and future work on HIME:

- A self-consistent treatment of particle precipitation to fully understand the effects of meso-scale structures.

Thank you.

Friday 13th December 2019, 15:28-15:40
SA53A-09: Results from a new approach to meso-scale driving of the I-T system

Acknowledgements

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- Part of the simulation results have been provided by the Community Coordinated Modeling Center at Goddard Space Flight Center through their public Runs on Request system (http://ccmc.gsfc.nasa.gov). The Weimer Model was developed by Daniel R. Weimer at Virginia Tech. The Ovation Prime Model was developed by Patrick Newell at JHU/APL.
- The authors gratefully acknowledge Mark Conde for maintaining the SDI data at \url{https://sdi_server.gi.alaska.edu/sdiweb/index.asp} and ASI data at \url{https://optics.gi.alaska.edu/optics/}.
- We thank the developers of Spacepy (\url{https://github.com/spacepy/spacepy.git}), AACGMV2 (\url{https://github.com/aburrell/aacgmv2.git}), and Dascutils (\url{https://github.com/space-physics/dascutils}) libraries, which were used in this study.

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